If there is magic on this planet, it is contained in water.
Loren Eiseley
The Immense Journey (1957)

REMEDIATION

Streamside Solution

There are more than 3 million miles of streams in the United States, forming a significant part of our total watershed. Human activity frequently results in streamside vegetation being cut back or damaged, which can destabilize the stream bank and bury algal and microorganism populations under eroded and deposited sediment. It can also increase the amount of light falling on a stream, potentially increasing algal growth. A recent report suggests there are more benefits to keeping streamside vegetation intact than meet the eye. This greenery also appears to play a critical role in removing contaminants from stream waters.

"When you look at a stream," says Oak Ridge National Laboratory scientist Patrick Mulholland, "your overriding impression centers on the flow. To the casual observer, it seems that whatever is in the stream, or gets dumped into it, just gets carried along to the next large body of water. It's only recently we've begun to realize that isn't accurate."

In the September 2004 issue of *Biogeochemistry*, Mulholland reported on a 12-year study of the West Fork of Walker Branch, a small stream in eastern Tennessee. His study to date has revealed that there's a tremendous amount of biological activity going on in streams, and that streamside vegetation plays a key role. According to Mulholland, a healthy growth of streamside vegetation can diminish the nitrogen and phosphorus load in the stream to the point that it reduces the risk of the nitrogen-driven algal blooms that plague many of the country's lakes and coastal waters. He explains that the biological activity of small streams, because of their higher surface-to-volume ratio, takes place at a greater rate than that of larger streams.

The biological processes in a stream are driven by two factors: the sun, which provides energy for algae and bryophytes such as mosses, and the vegetation debris—the leaves, branches, and logs that fall into the stream—which provides energy for the microorganisms that remove the nitrogen and phosphorus from the stream water. Larger pieces of debris also help trap smaller debris particles, further enhancing the community.

Bank on it. Results of a 12-year study show that renewing streamside vegetation may be the best bet for removing chemicals from streams.

Over the 12-year study, Mulholland says, these in-stream processes removed an average of 20% of the nitrate and 30% of the dissolved phosphorus entering the stream from the surrounding catchment. These common pollutants often enter the stream through inputs of sewage or lawn and farm fertilizer, and both may also be deposited atmospherically. Mulholland's study indicated a much lower level of nitrate and dissolved phosphorus during the autumn and spring as a result of uptake by organisms within the stream. In fact, he says, November showed the greatest uptake of these pollutants, probably driven by microbes colonizing the newly fallen autumn leaves.

Streamside areas can and should be replanted, Mulholland says, but with some care. It is easier and cheaper to plant banks with short grasses rather than woody native vegetation, he says, but while grasses might help stabilize the bank to some degree—although less so than trees and shrubs will—they won't add the needed organic material. "Best is to regrow the natural vegetation," Mulholland says.

There is a very close relationship between healthy streamside vegetation and the health of the waterway, agrees Margaret Palmer, a professor of biology and entomology at the University of Maryland. "The problems we're having with areas like the Everglades, the Great Lakes, and the Chesapeake Bay are all a function of what moves downstream. The microbes [Mulholland] is researching play a tremendous role—they remove nutrients from the water, they help break down toxics like petroleum byproducts, some even help fix heavy metals and remove them from the water. We have to preserve and restore these streamside areas, not because it looks good, but because it will directly impact the quality of our lives."

Palmer points out that the riverside vegetation itself also helps remove nutrients, as do the microbes in the soil of the stream banks. This complex system of nutrient processing—and not just in-stream processing—leads to the best water quality, she says.

We're coming to realize that streamside vegetation is important in ways far beyond its appeal to our sense of aesthetics, Mulholland says. "We have a responsibility to maintain the ecological health of the stream system," he asserts. "In many ways, the lands bordering our streams are among the most important part of our landscape."

–Lance Frazer

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CHEMICAL EXPOSURES

Genes and Sensitivity

People who suffer from multiple chemical intolerances, a condition sometimes referred to as "multiple chemical sensitivity," report wide-ranging symptoms such as headaches, short-term memory problems, confusion, fatigue, depression, irritability, and breathing difficulties. Is this phenomenon the result of a decreased physical tolerance to small amounts of chemicals such as pesticides and solvents, or is it an irrational fear of chemicals or a manifestation of psychological stress, as some have suggested? A study by University of Toronto epidemiologist Gail McKeown-Eyssen and her colleagues suggests that the condition may actually have a genetic basis.

The study, reported in the October 2004 *International Journal of Epidemiology*, investigated for the first time genetic differences between women reporting multiple chemical intolerances and those without such intolerances. Although both women and men report multiple chemical intolerances, several studies suggest that many more women than men may be affected.

The researchers recruited 203 cases and 162 controls from female respondents to a University of Toronto health survey. They identified multiple chemical intolerance sufferers using criteria derived from earlier studies, including one by James R. Nethercott and colleagues in the January/February 1993 *Archives of Environmental Health*, which defines cases as those with symptoms that are chronic, that are linked to a low level of exposure to chemical agents, and that resolve with removal of the exposure.

The Toronto researchers found that cases were significantly more likely than controls to exhibit specific polymorphisms in one or both of two genes, CYP2D6 and NAT2. CYP2D6 codes for enzymes that metabolize chemicals such as medications that target the central nervous system (including various antidepressants, stimulants, and codeine—all drugs with different chemical structures), drugs of abuse, neurotoxicants, procarcinogens (substances that become carcinogenic only when metabolized into more reactive compounds), and even the body's own neurotransmitters. NAT2 also plays a role in metabolism of various drugs and toxic chemicals, including aromatic amines, a class of chemicals used in the production of epoxies and dyes.

Women whose polymorphism gave them higher CYP2D6 activity were more than three times more likely to be chemically intolerant than those with the inactive form of the gene. Likewise, women with the so-called rapid-acetylator form of NAT2 were four times more likely to report multiple chemical intolerances. Because metabolism of some chemicals can result in toxic by-products, people with rapid metabolisms could be more quickly accumulating toxic compounds in the body. "It depends on the compound, what the metabolites are, and how quickly they're cleared from the body, as to whether having rapid metabolism results in more exposure or less exposure," McKeown-Eyssen says.

The researchers found an even stronger association in women who showed the rapid-metabolizing form of both CYP2D6 and NAT2. These women were 18 times more likely than control subjects to suffer from multiple chemical intolerances. McKeown-Eyssen is particularly cautious about this finding because the analysis for such an interaction was not part of the original study design. "We have to be really careful about that observation," she says. "But if it's true and can be replicated, it means that some people are at very high risk."

If replicated, these findings may provide evidence of a physical origin for this enigmatic disorder. It was only in 1994 that the American Medical Association acknowledged in a joint statement with other organizations that chemical intolerances should not be dismissed as psychogenic.

Claudia Miller, a professor of environmental medicine at the University of Texas Health Science Center at San Antonio, says that the three- and four-fold increases in risk associated with the polymorphisms are notable, and that the findings are important in suggesting a physical basis for these illnesses. "It's hard to say that genetic polymorphisms are psychogenic," she says. "For a long time we've known there's a spectrum of [chemical intolerance] susceptibility in the population, and it should not be a surprise that it's genetically based."

McKeown-Eyssen says that after these results are replicated, further research should include studies of the function of the enzymes coded for by these genes. It might also be reasonable, she suggests, to look for other genes involved in chemical intolerance, since this study found an association when looking at only a few of the many genes involved in detoxification of chemicals. **–Angela Spivey**

LAX Pays Its Neighbors Back

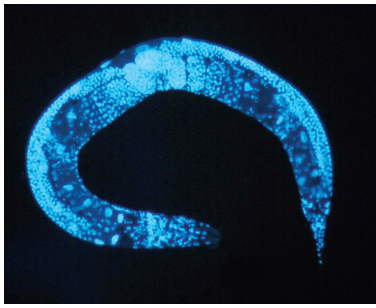
A first-of-its-kind community benefits agreement was signed in December 2004, providing a benefits package worth millions in coming years to residents living near Los Angeles International Airport. The airport, the second largest industrial smog source in the Los Angeles area, currently supports about 1,000 flights each day, and a major expansion project is in the works. The deal includes monies for soundproofing of schools and homes, and encourages green building and energy conservation practices. The agreement also calls for studies on the sources and health risks of toxic air emissions from local sources, including the airport.

Cookstove Monitors Tested in Honduras

Handmade wood-fueled cookstoves are widely used throughout the developing world. The smoky stoves produce large amounts of particulate matter inside the home, affecting the health of everyone living there, especially women and children, who spend the most time indoors. Now a team from the University of Illinois at Urbana–Champaign has designed a portable, battery-operated sampling cart to measure emissions in remote locations. The cart has sensors for measuring carbon dioxide and carbon monoxide, instruments for measuring particle color and concentration, and filters for collecting particles for later analysis. Onsite sampling lets researchers see how actual cooking practices (such as the type of wood used) affect stove outputs. The carts have been used in a baseline study in Honduras and will be used again in summer 2005 to measure emissions from new, more efficient stoves that have been distributed.

Watch Out, Worms!

What do colorless, see-through, tube-shaped organisms made up of only 959 cells have in common with laboratory rats . . . and with humans? A new five-year, $4 million study at Duke University funded by the National Toxicology Program seeks to determine just that. *Caenorhabditis elegans*, the subject of the Duke study, lives in soils around the world, where it feeds on bacteria. The worm has already been extensively studied, but this project will focus on developing rapid toxicologic assays using the organism. Such assays should help lower the costs of and number of rodents needed for carrying out a typical toxicology assay.



Top to bottom: Thinkstock; National Human Genome Research Institute

MEETING REPORT

Investigating Indoor Air

Americans spend about 85–95% of their time indoors, and in recent years, the indoor environment and its potential effects on health have become the subject of increasing research attention. Seeking to explore the existing knowledge and stimulate new ideas for action, the nation's top public health officer convened a gathering of more than 300 experts from government, academia, the building materials and design industries, and public interest groups for a two-day conference in January 2005.

The Surgeon General's Workshop on Healthy Indoor Environment began with presentations of the scientific evidence that exposure to polluted indoor air is making many people sick. Those exposures include chemicals (such as volatile organic compounds and pesticides), biological agents, other particulates, environmental tobacco smoke, excessive dampness, and poor ergonomic, noise, thermal, and lighting conditions. Eileen Storey, director of the University of Connecticut Center for Indoor Environments, said surveys indicate that on average 40–55% of office occupants experience some degree of so-called sick building symptoms (such as headache, cough, wheezing, and fatigue) on a weekly basis.

Speakers discussed the 2004 Institute of Medicine report *Damp Indoor Spaces and Health*, an exhaustive literature review which concluded that excessive indoor dampness and fungal growth are consistently and convincingly associated with respiratory health effects, including asthma. The report delineated research needs in the area, including reproducible, validated measurement and risk assessment methods. Peyton Eggleston, a professor of pediatrics and immunology at the Johns Hopkins School of Medicine, said, "We [also] need an intervention study that will take a damp building, remediate it, and show in a rigorous scientific way that there is both a measurable environmental impact and a measurable health impact."

There was also a consistent call to implement good practices based on current knowledge, and to express the benefits of improving indoor air quality in terms of economic value, so building owners, operators, and occupants can appreciate that such investments make bottom-line sense. Storey presented estimates from the September 2002 *American Journal of Public Health* that improving indoor air may save businesses $5–75 billion annually through fewer sick building symptoms, communicable respiratory diseases, allergies, and asthma attacks, with concomitant gains in productivity. "If we calculate it in those ways," said Storey, "people will immediately say, 'It's worth it to run my building in a way that people are not going to get sick.'"

Focus on fumes. A recent workshop reviewed the many sources of indoor air pollution and what can be done about them.

Several participants cited the need for well-defined standards of what constitutes a healthy indoor environment, perhaps including a building rating system. Several government agencies represented at the workshop currently have research initiatives involving the indoor environment. Surgeon general Richard Carmona urged more collaboration, not only among federal agencies, but also in research and intervention partnerships with academia and the building professions. "The issue of a healthy indoor environment is key to improving the health of the American people," he said. "Clearly the time has come for action in this area." **–Ernie Hood**

CANCER

New Chlorpyrifos Link?

Chlorpyrifos, one of the most widely used organophosphate insecticides in the United States, is a known neurotoxicant, but is it carcinogenic too? A team of National Cancer Institute (NCI) researchers recently reported on the first epidemiologic study to carefully evaluate cancer among chlorpyrifos applicators. Their results suggest a possible link between the insecticide and lung cancer.

Chlorpyrifos's neurotoxicity led to its 2000 ban from numerous residential uses, including termite suppression and use in pet collars. Nevertheless, it is still widely used for many nonresidential purposes, including pest control for turf and ornamental plants. It may be used indoors in warehouses, ship holds, boxcars, factories, and food processing plants, or as containerized pesticide baits in child-resistant packages. Currently, about 800 registered products contain this compound.

The current evaluation was done as a part of the Agricultural Health Study, which is supported by the NCI, the NIEHS, and the Environmental Protection Agency (EPA), in collaboration with the University of Iowa and Battelle. Won Jin Lee, a visiting fellow in the NCI Occupational and Environmental Epidemiology Branch, and his team evaluated the incidence of cancer among a cohort of 54,383 licensed pesticide applicators in Iowa and North Carolina. They assessed the association between chlorpyrifos exposure and cancer incidence after adjusting for known or suspected confounding factors. Study subjects were recruited between 1993 and 1997 and followed for an average of 6.4 years.

About 3.8% of the applicators developed malignant lung neoplasms. The researchers found a statistically significant exposure–response relationship between increasing chlorpyrifos exposure and lung cancer, but not for any other cancer examined. The most frequent users of chlorpyrifos had a relative risk of lung cancer of about twice that of nonusers, an association that could not be explained by smoking, previous lung disease, other occupational exposures, or type of farming operation. The results were published in the 1 December 2004 issue of the *Journal of the National Cancer Institute*.

Study coauthor Aaron Blair, a senior investigator in the Occupational and Environmental Epidemiology Branch, says, "The elevated risk of lung cancer observed must be balanced against the general lack of evidence for [chlorpyrifos's] carcinogenicity from experimental investigations. This issue will be further evaluated in a future follow-up of the Agricultural Health Study cohort."

Debra Edwards, director of the Special Review and Reregistration Division in the EPA Office of Pesticides, says the EPA agrees that the new study must be considered along with all the available animal studies showing that chlorpyrifos does not cause cancer. She says, "[The EPA] will continue to work with the NCI and others as the postulated link beween chlorpyrifos and lung cancer is sorted out. **–Julian Josephson**

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ehpnet Great Lakes Information Network

The Great Lakes Information Network (GLIN) is a partnership of public and private organizations managed by the Great Lakes Commission, an eight-state compact agency. The GLIN website, located at http://www.great-lakes.net/, serves as a central online source for information about the Great Lakes region. A strong network of state, provincial, federal, and regional partner agencies and organizations populate the GLIN with essential information for use by policy makers and others with an interest in the region.

The site's homepage is divided into six different topic sections, plus a daily news page featuring current news articles, press releases, announcements, and links to information about lake conditions and weather forecasts. Visitors can sign up to receive daily news or to submit stories.

The Great Lakes section of the site features an interactive map of the region. Clicking on different geographic areas brings up state-, province-, or lake-specific news as well as links to general resources (such as governmental programs, state facts, and information on Sea Grant programs), economic profiles, environmental information, and tourism sites.

The Environment section of the GLIN site groups information into five topics, each with several subtopics. The main topics are Air and Land, Water, Flora and Fauna, Pollution, and References. Subtopics include sustainable development, air toxics, human health, toxic contamination, and environmental justice, among many others. This section also provides an overview of the Great Lakes natural environment and general resources including an online atlas of the region published by the U.S. Environmental Protection Agency, back and current issues of Environment Canada's *Science and the Environment Bulletin*, and the Commission for Environmental Cooperation's summary of environmental law in North America.

Similarly, the Economy section includes information grouped under the main topics of Business Development, Business and Environment, and References, with agriculture, energy, economic development, and transportation among the subtopics.

Aimed specifically for teachers, the Education portion of the site features free online "mini-lesson" modules for students in elementary through high school. Subjects covered in the lessons include the natural environment, geography, and pollution. The natural environment module features information on water diversion out of the region, invasive species, and protection of water quality. The causes and effects of Great Lakes pollution is the main focus of the pollution unit, which also includes a section on urban sprawl. An online glossary helps students with unfamiliar terms used throughout the modules.

The Maps and GIS (geographic information systems) section of the site offers resources to help visitors customize their own Great Lakes map using GIS data (searchable by topic, region, or organization), online mapping tools, and a gallery of free downloadable maps. The types of maps offered range from ecological assessment maps to satellite images.

Finally, the Tourism section of the site, with its extensive list of local recreational, cultural, and historical offerings, provides one small hint of the richness of this magnificent natural resource we call the Great Lakes.

–Erin E. Dooley

Overfishing and Bushmeat

Companies from the European Union fish heavily off the West African coast, with financial subsidies for fleets topping $350 million in 2001. Now a report published 12 November 2004 in *Science* states that declining fish stocks—down by at least 50% since 1970—are forcing local peoples to slaughter wildlife, or "bushmeat," for food. Over the same time period, this demand for bushmeat has led to a 76% decline in the numbers of 41 species of mammals, including buffalo, antelope, jackals, monkeys, and elephants; several species are now near extinction. The study group states that measures are urgently needed to help local peoples find cheap and readily available alternative protein sources. Furthermore, until larger issues such as international fish export agreements are addressed, local efforts to prevent wildlife extinction will fall short.

Counting Sea Creatures

It is believed that only 5% of the world's oceans have been explored so far, but new technologies are opening up new areas of the underwater world every day. In November scientists announced they had discovered 106 new species of fish in 2004 alone as part of the 10-year Census of Marine Life, begun in 2000. More than 1,000 scientists from 70 countries are taking part in the census. Facilitating the exchange of this new information is a publicly accessible database (http://www.iobis.org/). The census database has more than 5.2 million records mapping the distribution of 38,000 marine species, a significant increase from the 1.1 million records of 25,000 species last year. To date about 230,000 marine species have been described by scientists. Census members believe the actual number of species may be 10 times that.

Anchoring Toxic "Ghost Ships"

The parties to the Basel Convention affirmed in October 2004 that aging oceangoing ships, often called "ghost ships," are to be considered toxic waste under international law, meaning they cannot be exported for dismantling. Until now such ships were often sent to countries such as India, Bangladesh, Pakistan, Turkey, and China, where laborers would break down the vessels to recover valuable steel. The ships often contain asbestos, PCBs, mercury, lead, waste fuel oil, and other toxic substances that contaminate the areas around the shipbreaking yards. The convention now has asked its Open-Ended Working Group to consider a legally binding ban on the movement of such ships to be voted on at the convention's 2005 assembly.

Top to bottom: Sven Torfinn/Panos Pictures; GLIN; Fernando Moleres/Panos Pictures